On the Estimation of Efficiencies of Pyrethrins and Allethrin as Fly Repellent. Insect Repellents and Attractants. Part II. Yasunosuke IKEDA (Takamine Laboratory, Sankyo Co., Ltd. Yasu-cho, Shiga Pref.). Received Jan. 31, 1958. *Botyu-Kagaku*, **23**, 33, 1958.

6. ピレトリン及びアレスリンに対する家蠅の忌避性 忌避剤・誘引剤について 第2報. 池田安之助（三共株式会社 高峰研究所） 33. 1. 31 受理

イエバエがピレトリン，アレスリンに対して高度の忌避性を示し，これら物質の混用によつて合成忌避剤の効力が増強されることを知つた．他方，殺虫剤の効力延長剤として有効な chlorinated terphenyls は合成忌避剤の効力延長には役立たない結果を得た．またこれらとは別に，イエバエの薬物に対する contact 及び gustatory repellency を測定するのに簡便な装置を考案した．

The contributions of the bulk of research on repellents together with a history of repellents up to World War II were reviewed by Dethier[3,4]. Subsequently, in 1957, Dethier has been reviewed a comprehensive one of the sphere thereafter[5]. It is said from the results of numerous workers that the newest chemicals developed for insect control in the present day is repellent. Nowadays, many commercial repellents are on the market, and these show a high degree of repellency against the household insects, as well as a variety of other flying and crawling insects[1,2,6].

The repellent is a valuable substance to control insects in cases where toxic insecticides may not be freely used such as the human body, livestock, and around foodstuffs. Furthermore, not only repellency offers a safer method of insect control but the use of repellent is profitable to defend the increasing occurrence of resistant strain to certain insecticide. Thus, repellent has a good character of great advantage to insect control but, in practical use, its residual effect is of short duration.

In this paper the author has reported on the increase of repellent efficiency of certain commercial repellent by the addition of some suitable substances, specially with the estimation of pyrethrins and allethrin as fly repellent.

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Methods and Materials

The insect used was the adults of the common housefly, *Musca domestica vicina* Macq. which have been bred in the laboratory. The mass culture medium consisted of 85% "Okara", beancurd refuse, 1% pepton, 4% dried yeast and 10% dried rice stem by weight which described by Nagasawa[9] was used for breeding larvae.

In the case of the test, about 100 adult houseflies of 2 to 3 days old were used for each test.

The materials adopted for test were pyrethrum extract containing 17.4% of pyrethrins, commercial allethrin having 97.7% of purity, Tabutrex[1], di-*n*-butyl succinate, one of the repellents that has been tested extensively, and chlorinated terphenyls. Chlorinated terphenyls are generally used as thermo-stabilizer and plasticizer, are colourless and odorless, viscous liquids, soluble in a variety of organic solvents. Chlorinated terphenyl-I～III having a specific gravity between 1.370 to 1.555, 100°/4°, and Redwood viscosity at 97° ranging 36 to 65, and merely chlorinated terphenyl-IV, a resinous substance with the specific gravity 25°/4° of 1.670 to 1.690.

Test formulations were made by dissolving each material in benzene and to gave the desired concentration.

The previous tests were conducted in the glass box of 24×24 cm and 15 cm high, with wire net in the bottom[8]. While, in the present tests, a new model which improved on former type was used. The new apparatus, Fig. 1, consisted of glass

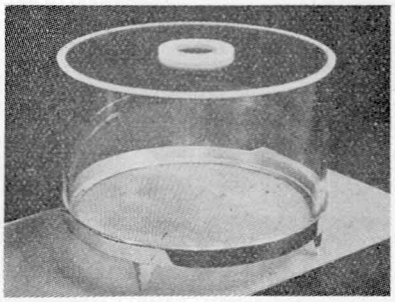

Fig. 1. Apparatus for testing the contact and gustatory repellencies of chemicals to adult houseflies (Designed by the author). Flies are flown or crawled freely under the limited condition, and they feed on lactose pellet on each paper, where they do not able to approach the paper with lactose pellet when the paper has been treated with repellent.

cylinder of 25 cm in diameter and 15 cm high, a metallic frame with wire net in the bottom, and glass cover with a hole in the center. This apparatus can conveniently be used so that it can be taken apart at will.

The tests were conducted in a dark-room in order to avoid certain tendency of housefly to react to the light, colour and other factors. In my tests, however, there was no difference between absence and presence of light in result.

In the tests, benzene solutions containing a given concentration of the materials were applied at a rate of 0.2 cc per filter paper of 5 cm in diameter (about 20 cm^2). The impregnated filter papers were kept at 26° to 32° for various time. After a given time had elapsed, about 50 mg of lactose pellet was placed in the center of each paper, these papers with pellets were put into a test cylinder containing about 100 houseflies.

The criterion of repellency was based on the amount of feeding on lactose pellet put on each paper. After the exposure of 20 hours the lactose pellets were removed and weighed. The amount of lactose pellet (mg) fed by flies were represented by formulae as mentioned in the previous paper[8].

Results

In the first tests, Tabutrex (di-*n*-butyl succinate)

Table 1. Relative effectiveness and durability of test materials in benzene solutions against the adult of the common housefly, *Musca domestica vicina* Macq. in laboratory tests. Exposure for 20 hours at 28°—30°. Average of four replicates.

Formula Ingredient gram in 100cc benzene	Initial deposit in mg per 20cm^2		*Repellency per cent* Days after treatment*			
	Tabutrex	Cl. terphenyl	2	5	10	15
Tabutrex 5 alone	10	—	100.0	81.0	57.6	5.7
Tabutrex 5 plus Cl. terphenyl-I 5	10	10	100.0	74.2	54.1	0.0
Tabutrex 5 plus Cl. terphenyl-II 5	10	10	100.0	76.6	54.5	0.0
Tabutrex 5 plus Cl. terphenyl-III 5	10	10	100.0	78.2	58.9	0.0
Tabutrex 5 plus Cl. terphenyl-IV 5	10	10	100.0	83.7	59.3	6.3
Chlorinated terphenyl 5 alone	—	10	24.0	0.0	0.0	0.0

Significance between Tabutrex alone and Tabutrex plus chlorinated terphenyl-IV : $\chi^2=0.0427<\chi^2_{0.05}$ (d. f. 3)$=7.815$.

* The treated papers were kept at 26° to 30°.

Table 2. Relative effectiveness and durability of test materials in benzene solutions against the adult of the common housefly, *Musca domestica vicina* Macq. in laboratory tests. Exposure for 20 hours at 28°—30°. Average of four replicates.

Formula Ingredient gram in 100cc benzene	Initial deposit in mg per 20cm²		*Repellency per cent* Days after treatment*					
	Tabutrex	Toxicant	2	3	4	6	8	10
Tabutrex 5.0 alone	10.0	—	100.0	78.1	66.8	40.0	40.0	4.8
Allethrin 0.1 alone	—	0.2	100.0	74.9	77.9	40.3	35.5	10.5
Pyrethrins 0.1 alone	—	0.2	100.0	78.2	73.2	42.3	30.4	10.4
Tabutrex 5.0 plus Allethrin 0.1	10.0	0.2	100.0	94.2	91.3	60.2	55.5	10.5
Tabutrex 5.0 plus Pyrethrins 0.1	10.0	0.2	100.0	88.4	87.1	53.0	55.5	15.6

Significance between Tabutrex alone and in either combination with pyrethrins or allethrin: $\chi^2=8.8058<\chi^2_{0.05}$ (d. f. 10)$=18.307$.
* The treated papers were kept at 28° to 32°C.

formulated in 5% benzene solutions either alone or in combination with chlorinated terphenyls were used. Results are shown in Table 1.

The reason why chlorinated terphenyls were adopted for the test is that these materials were not toxic to insects, while, when used in combination with γ-BHC, not only permitted prolongation of the insecticidal effect but also brought about no degradation of contact poisoning action of γ-BHC on them, especially chlorinated terphenyl-IV was prolonged very much the residual effect of γ-BHC[7].

As shown in Table 1, however, these materials had no effect upon the prolongation of residual effectiveness of Tabutrex, on the contrary, its residual effect was reduced slightly by the addition of chlorinated terphenyl-I to III.

In the second tests, allethrin 0.1%, pyrethrins 0.1% and Tabutrex 5%, and their mixtures in benzene solutions were tested. The results are given in Table 2. Pyrethrins and allethrin gave good effects. Residual effect of these materials up to 4 days was attained, and these dosages applied in the test were nearly equal to those of common practical use. By the addition of pyrethrins or allethrin, repellent action of Tabutrex was increased in the early days of application, but have failed to give prolongation of repellency.

Discussion

Although it is generally recognized that pyrethrins is an effectual contact insecticide, it is still less known that it has a considerable repellent effect to insects. Of course, there has been a little knowledge with repellency that pyrethrum was effective against some biting insects such as *Glossina, Stomoxys, Haematobia* and *Culicoides*[3], but little is known about its effect against *Musca*.

In the preceding paper, the author dealt with the technique for evaluating the repellent efficiency to the adult of the common housefly and described the method of evaluating results. In the tests, the author recognized that houseflies dislike pyrethrins and allethrin, so they do not approach a filter paper which have been treated with them.

In order to authorize the above fact, further tests were carried out on the adult houseflies. As shown in the present paper, in consequence, it has been established the pyrethrins and allethrin gave highly effective in repelling

houseflies. If any material which prevent insects from crowding are termed as repellent, it may safely be said that pyrethrins and allethrin are efficacious repellent to houseflies.

Chemically, synthetic repellent is compatible with other insecticides, and in these days, in general, the use of combination of repellent and insecticide has been recommended as household, barn, or livestock sprays because of most of these repellents do not kill insects. It is generally said that repellent, when used in combination with insecticide, an insecticide is of great advantage to kill and a repellent to discourage insects from reinfesting[1,2].

Repellent itself is safe to use, but if, when combined with some toxic insecticides, there is tendencies of some danger would be occur. When the insecticides are long lasting ones we can expect to destruct pest population, and by these reasons, a combination of repellent and toxic insecticide is tolerable, but when the residual effect of insecticide is poor, killing effects can hardly expected, therefore such combination must be discarded.

In the present tests, both pyrethrins and allethrin, notwithstanding they are contact insecticides, gave high repellent effect to houseflies.

Synthetic repellent (Tabutrex), when used in combination with pyrethrins or allethrin, repellent action of Tabutrex was increased in the early days of application, but have failed to give prolongation of its residual effect. This might be due to disappearance of pyrethrins, allethrin and Tabutrex take place simultaneously.

The repellent effect varies with the species of insects. Certain synthetic repellents have proved to be effective against some specific insect, as yet, no chemical has been shown to meet all requirements for repelling agricultural and sanitary pests satisfactory.

Résumé

In the present paper, the author dealt with the estimation of pyrethrins and allethrin as fly repellent and their compatibility with certain synthetic repellent.

The method employed, in this work, was same as the technique described in the previous paper, except a new apparatus was used for the tests. Tests were made on the adult houseflies which have been bred in this laboratory.

As shown in the paper, it has been established the both pyrethrins and allethrin gave highly effective in repelling houseflies. If any material which prevent insects from crowding are termed as repellent, it may safely be said that not only pyrethrins and allethrin are contact insecticides but also they are efficacious repellent against houseflies.

By the addition of Pyrethrins or allethrin, repellent action of a synthetic repellent (Tabutrex) was increased in the early days of application, but have failed to give prolongation of residual repellency. It appears that disappearance of pyrethrins, allethrin and synthetic repellent take place simultaneously.

With the present paper it can only be concluded that, in the enhancement of repellent action, using a combination of repellent and insecticide such as pyrethrins or allethrin has been better than the use of repellent alone.

Literature Cited

1) Anonymous : Pest Control, **25**, (1), 22(1957).
2) Anonymous : Pest Control, **25**, (6), 28(1957).
3) Dethier, V. G. : "Chemical insect attractants and repellents". The Blakiston Co., Philadelphia, Penna., 289 pp. (1947).
4) Dethier, V. G. : Ann. Rev. Entom., **1**, 181 (1956).
5) Dethier, V. G. : Soap & Chem. Specialties, **33**, 83 (1957).
6) Gilbert, I. H. et al : Soap & Chem. Specialties, **33**, 115 (1957).
7) Ikeda, Y. : Ann. Takamine Lab., **7**, 202 (1955).
8) Ikeda, Y. : Botyu-Kagaku, **22**, 323(1957).
9) Nagasawa, S. : Bull. Inst. Chem. Res., Kyoto Univ. **34**, 101 (1956).